Introduction to the BTeV Project

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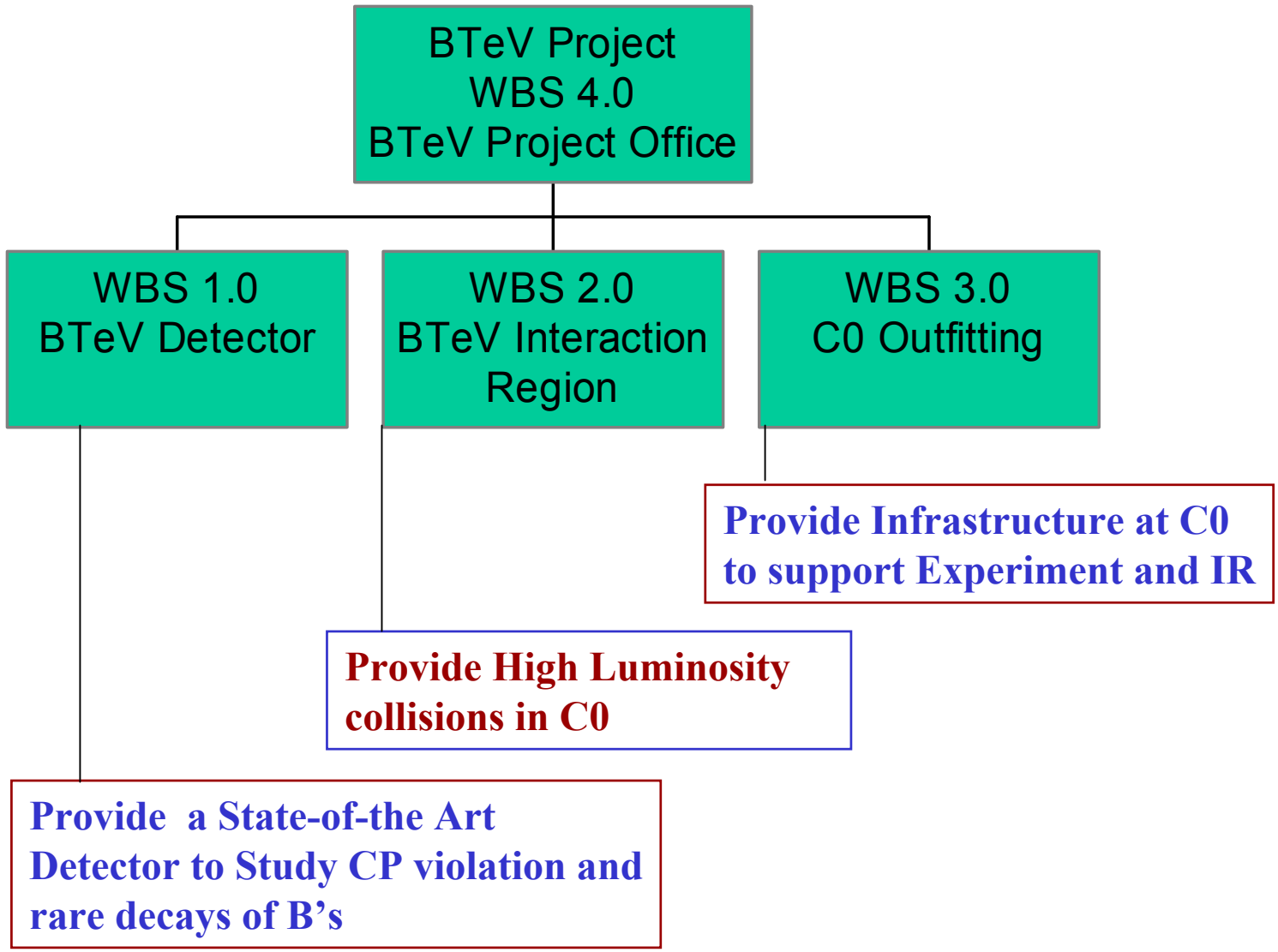
DOE CD1 Review

April 27, 2004

Overview

- The BTeV Project
  - WBS 1.0 – the BTeV Detector, including the Trigger and Data Acquisition System
  - WBS 2.0 – the Interaction Region
  - WBS 3.0 – C0 Outfitting
  - WBS 4.0 – BTeV Project Office, Project Management
- Project Organization and Status
- Cost Estimate
- Schedule
- Documentation for the Review
- Summary

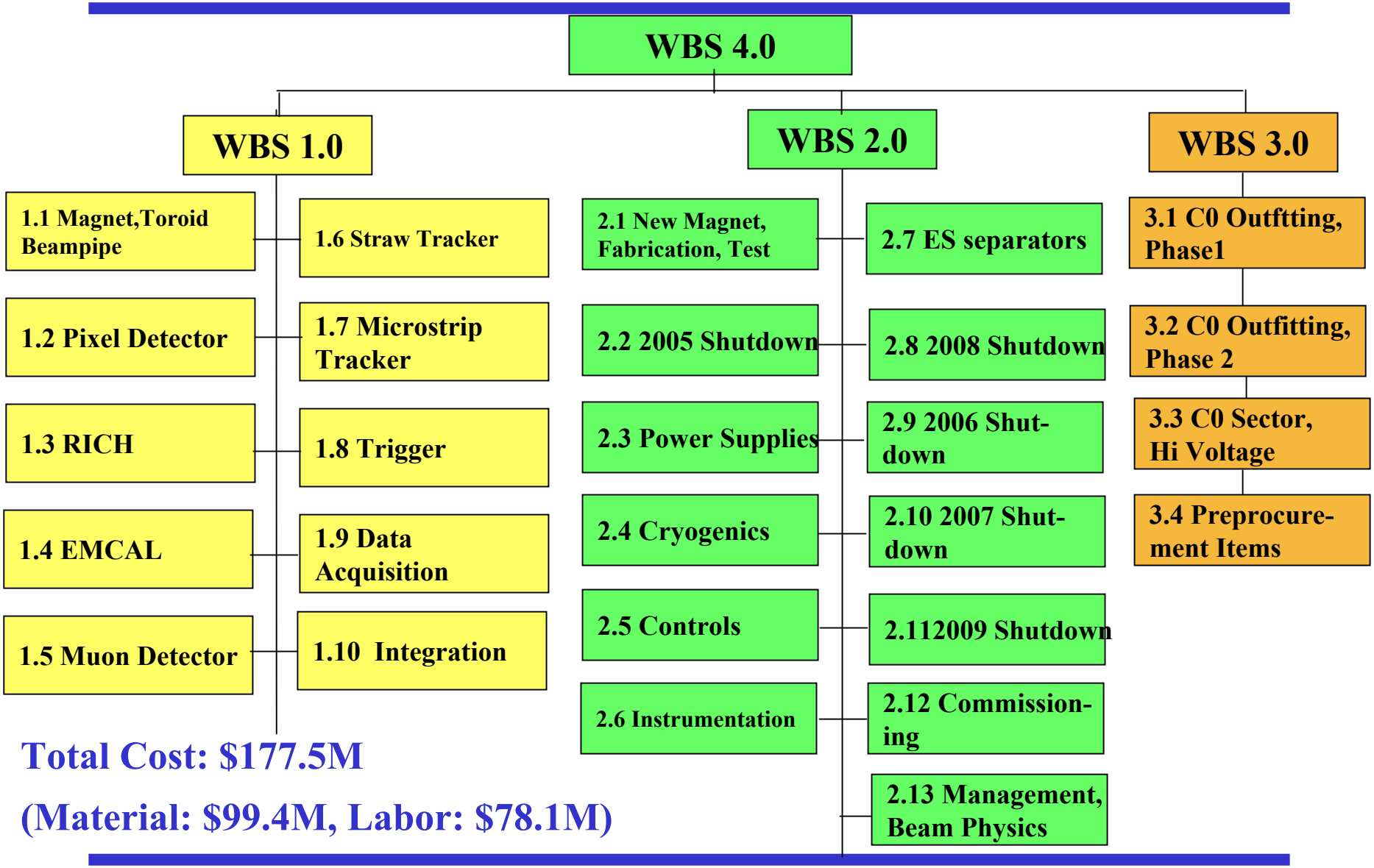
Introduction



Comment on Status of Subprojects

- The designs of the three subprojects are at different levels technically and in understanding of costs and schedules
  - **The detector has been designed by a large group, starting with a simulation effort in 1996 and then a substantial R&D effort beginning in 1998. It has a nearly complete technical baseline.**
  - **The lab has recently decided to implement a "custom IR" based on new magnets, rather than to reuse components from existing installations. The P5 recommendations support this. This part of the project requires design of a new low-β insertion and the construction and installation of the components. It has progressed rapidly and is past the conceptual design level**
  - **The C0 Collision Hall and Assembly Area was built in 1999-2000, but was not outfitted to support a large experiment. This project will complete the counting rooms, provide power and cooling required for BTeV and the IR, etc. It is past the conceptual design level and is ready for detailed engineering.**

Organization

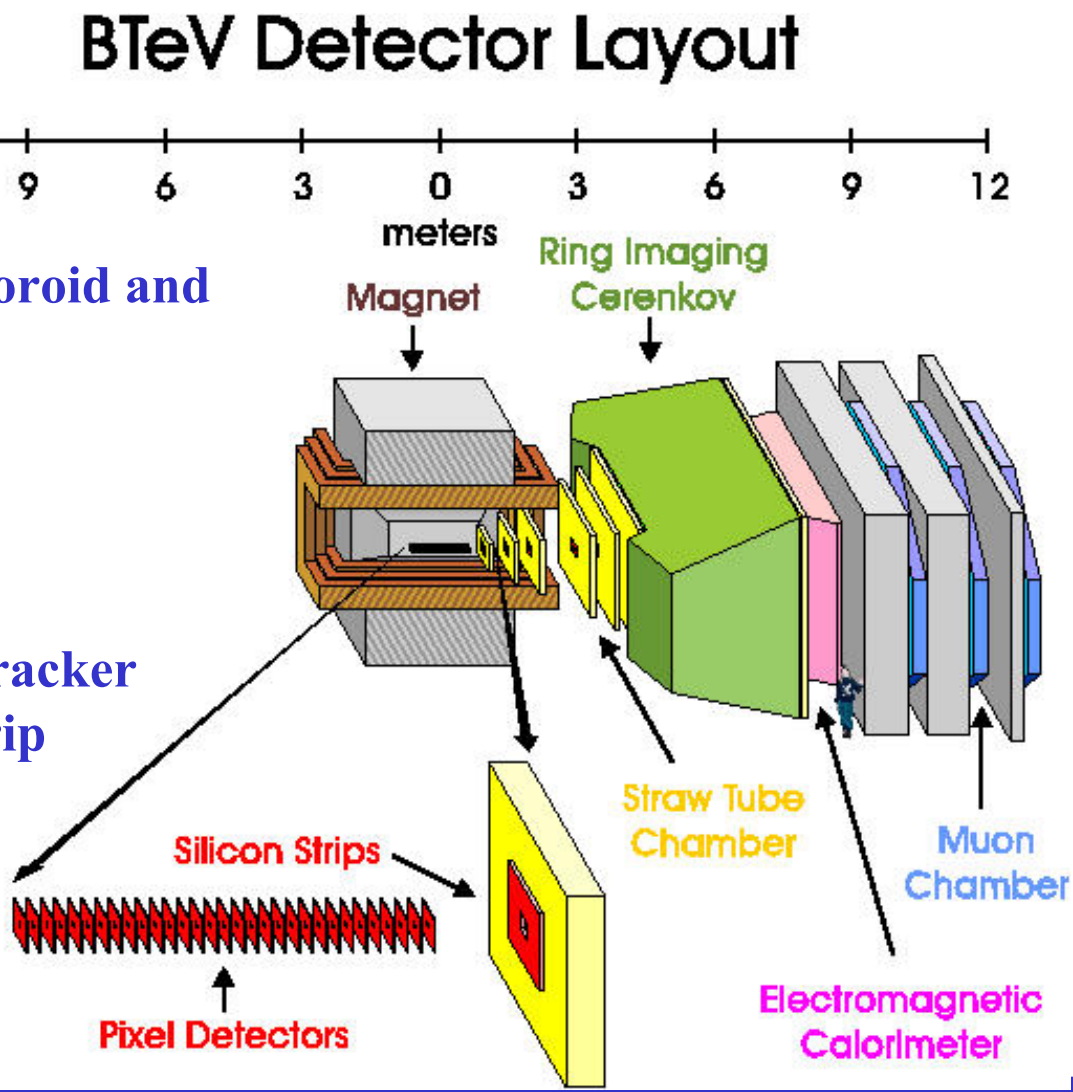


Total Cost: $177.5M

(Material: $99.4M, Labor: $78.1M)

Work Breakdown Structure - Detector WBS 1.0

1.1 Vertex Magnet, Toroid and Beam Pipe
1.2 Pixel Detector
1.3 RICH
1.4 EMCAL
1.5 Muon Detector
1.6 Forward Straw Tracker
1.7 Forward Microstrip tracker
1.8 Trigger
1.9 Data Acquisition
1.10 Installation, Integration,etc (I&I)



Level 2 Managers WBS 1.0

1.1 MagnetsToroids,Beampipes ($2.2M)	Chuck Brown
1.2 Pixel Detector ($21.7M)	Simon Kwan
1.3 Ring Imaging Cherenkov($16.5M)	Marina Artuso, Tomasz Skwarnicki
1.4 Electromagnetic Calorimeter ($16.3M)	Yuichi Kubota
1.5 Muon Detector ($5.1M)	Paul Sheldon
1.6 Forward Straw Tracker ($12.3M)	Alan Hahn
1.7 Forward Silicon Microstrip($10.0M)	Luigi Moroni
1.8 Trigger ($17.0M)	Erik Gottschalk
1.9 Event Readout and Control ($16.3M)	Klaus Honscheid, Margaret Votava
1.10 Integration ($10.3M)	Joe Howell

NOTE: UNLESS OTHERWISE STATED, COSTS ARE FULLY BURDENED, WITH CONTINGENCY, IN FY05 $

Detector Technical Status WBS 1.0

- We have had a highly efficient R&D program which is succeeding on all fronts
- The BTeV Detector design has been quite stable for several years. We have changed the design of the pixel support, cooling, and vacuum systems following the strong recommendations of previous reviews.
- No "gotcha"s. Many "plans" in 2000/2001/2002 are well on their way to realization today. **Test beam work at Fermilab is beginning again.We have a very successful test beam program at IHEP/Protvino**
- There is a DRAFT Technical Design Report that is close to completion and will be the technical baseline for the detector.

Interaction Region WBS 2.0

- The quadrupoles that focus the beams at the IP are farther away than for CDF and D0 so optics based on their components only gets 0.32 as much luminosity as at B0/D0
- **A custom design, based on LHC quadrupoles, can raise this to the SAME luminosity as CDF and D0. This approach was recommended by the P5 Subpanel of HEPAP and is now chosen as the baseline plan. BTeV's luminosity need is consistent with the lab's current plan for RUN II.**
- Significant design work has been done and an Advanced CDR has been written. A list of elements that must be built has been prepared and is the basis of a cost estimate and schedule.

IR Status

- Mike Church, Accelerator Division, is in charge of IR subproject.
- Jim Kerby of the Technical Division is in charge of Magnet Production part.
- An Advanced Conceptual Design Report has been completed
- An Internal Review of the IR was held on Feb 18, 19

Total Cost= $36.0M, M&S= $18.1M, Labor =$17.9M

This design produces a β^* of 35 cm, same as at B0 and D0. BTeV luminosity will be the same as at B0/D0 when BTeV begins to run in 2009ish.

2.1 New Magnets ($23.8M)	Jim Kerby Deepak Chichili John Tompkins
2.2 2005 Shutdown ($0.8M)	Peter Garbincius
2.3 New Power Supplies ($3.5M)	George Krafczyk
2.4 Cryogenic Systems ($1.9M)	Jay Theilacker
2.5 Controls ($0.6M)	Sharon Lackey
2.6 Instrumentation ($0.2M)	Randy Thurman-Keup
2.7 Electrostatic Separators ($1.0M)	Roger Bossert
2.8 2008 Shutdown ($0.9M)	Rob Reily
2.9 2006 Shutdown (currently no work planned)	Rob Reilly
2.10 2007 Shutdown ($0.6M)	Rob Reilly
2.11 2009 Shutdown ($2.6M)	Rob Reilly
2.12 Hardware commissioning ($0.1M)	Gerry Anala
2.13 Overall project management	Mike Church (IR Leader) Peter Garbincius John Johnstone (beam physics)

Results of Internal Review of the IR WBS 2.0

- "A conceptual design report (CDR) for the BTeV Interaction Region (IR) has been written. This CDR sets forth the requirements of the IR for BTeV operations and describes concepts for meeting these requirements. It presents the accelerator physics and beam optics design for the IR and addresses the conceptual design for the superconducting magnets and correctors, and cryogenic systems, vacuum systems, controls, and beam instrumentation required to support the new BTeV low beta interaction region. **The conceptual design is judged to be a reasonable basis for proceeding to the more detailed design for the IR."**
- **"The accelerator physics design has progressed to the stage that it can be "frozen" and considered the basis for component selection and component design decisions. Additional work on tracking is desirable"**

IR Design Plan WBS 2.0

- The plan is to use modified LHC quadrupoles because they are the elements we have the most recent experience with at FNAL.
- They need to run at 4.5° K rather than the design 1.9° K.
- The cryostat will be reduced in diameter so the magnet doesn't intersect the tunnel floor. Work has already been done on this.
- The corrector package design and power leads are still design issues. There is still room for optimization and value engineering

The superconducting wire, correctors and high current leads are items that need to be "long lead-time procurements".

C0 Outfitting WBS 3.0

- **Site Construction: hardstands, utility pads, gas shed,…**
- **Mezzanine construction: walls, roofing, flooring, finishes (painting, carpeting), computer floor for counting room**
- **Elevators**
- **Cooling and HVAC: Chillers, Computer room cooling, Natural Gas**
- **Plumbing**
- **Electrical: lighting, substations, emergency generator, feeders**
- **Fire Detection**

This subproject has an Advanced CDR and a project team, including an engineer. It is divided into 3 phases for budgetary and technical reasons, but in a manner that always provides the access and facilities needed to carry out detector and IR related activities in the C0 area.

Project Organization and Cost WBS 3.0

3.1 C0 Outfitting Phase 1 **($2.7M)**

3.2 C0 Outfitting Phase 2 **($2.8M)**

3.3 C Sector High Voltage **($0.9M)**

3.4 Pre-procurement items **($0.8M)**

The leader of this project is Tom Lackowski, Facilities Engineering Support Section (FESS) and his task coordinator is Emil Huedem. He will have a construction coordinator and a procurement administrator

Total Cost = $7.2M, M&S= $5.1M, Labor $2.1M

Project Office

- **Project Director: Joel Butler**
- **Deputy Project Director: Sheldon Stone**
- **Project Manager: Michael Lindgren (starts May4)**
- **Scheduler: Bill Freeman**
- **Budget Officer: interviewing candidates**
- **Project Electronic Engineer: Ed Barsotti**
- **Project Mechanical Engineer: Joe Howell**
- **Project Software Engineer: Margaret Votava**
- **Consultant: Bob Downing**
- **Administrative Support: Lauren Curry**

- **Integration Physicist (TBD)**
- **Procurement Liaison: Joe Collins**
- **Safety Liaison: Martha Heflin**

Total Cost = $6.5M, M&S= $0.7, Labor $5.8M

- BTeV does not have unusual ES&H issues and has received a NEPA Categorical Exclusion
- A Preliminary Hazard Assessment Document has been written and is being reviewed.
  - The conclusion is that "operations at BTeV are characterized as low hazard."
- We have a Safety Liaison – Martha Heflin of Particle Physics Division
  - There are four FNAL divisions involved in BTeV and attention is being given to making sure there are clear lines of responsibility

BTeV Resource Loaded Cost and Schedule

- The project is being managed using an integrated suite of project management software from WELCOM, inc.– Open Plan (scheduler), COBRA, and WelcomHome.
- The cost estimate is derived from a complete, task-oriented WBS. Realistic assumptions are made about the production model. We have worked hard to include integration activities in a complete and consistent manner
- Estimate starts in FY2005, when we will become a construction project. IT IS IN FY2005 DOLLARS.
  - **Includes contingency, labor rates for all institutions including Fermilab, overhead on labor.**

Contingency

- We develop a bottoms up contingency based on maturity of design using a consistent methodology for M&S and labor. It results in a contingency of about 36%. We believe this is reasonable because
  - **The BTeV detector and C0 IR are new but many pieces have been or are being built elsewhere, so some parts can have relatively low contingency.**
  - **Our Cost Estimate is unusually complete for this stage in the project. In many cases, we are dealing with known vendors and have solid quotes**
  - **The scope has been stable for several years**
  - **There are parts that use new or unproven technologies and those do have much higher contingencies**

Cost and Scheduling Information

- All the projects have been implemented in OpenPlan. They all have the ability to show all manner of resource profiles.
- We have "linked" the subprojects into a "master project". This allows us to get resource profiles and costs for the whole project.
- OpenPlan calculates the critical paths and detailed floats for each subproject. People are using this to understand critical paths and to look for scheduling problems.
- You will be shown some of this work in the various breakout sessions. Because we cannot provide each reviewer with an OpenPlan license or training in using it, we have made some "standard profiles" and provided them to you in PDF format.
- We also have a web based browser, a.k.a. OBrowser, that will enable you to look at the subprojects in detail.

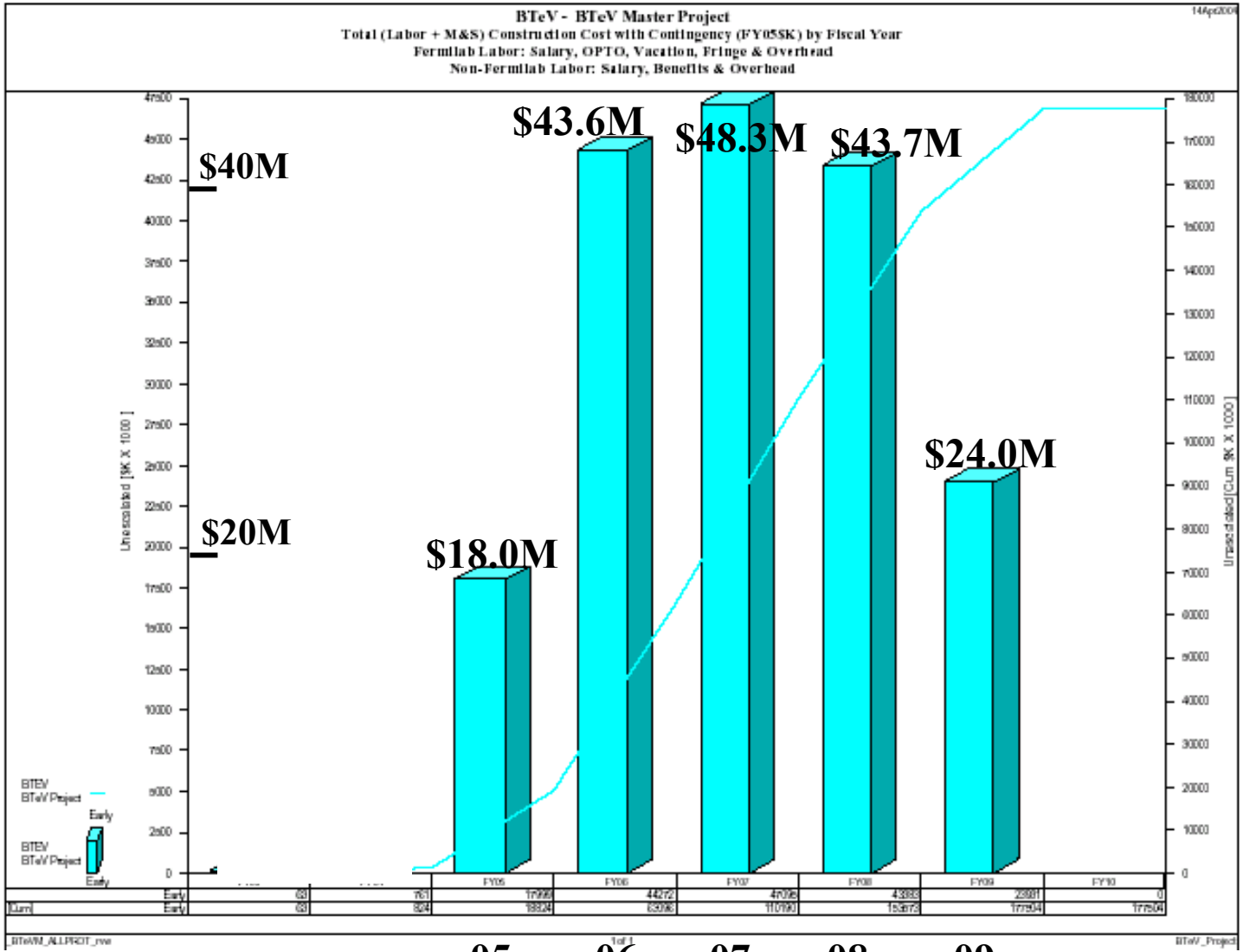
Total Cost (FY05$)

Activity ID	Activity Name	Base Cost ($)	Material Contingency(%)	Labor Contingency(%)	Total FY05	Total FY06	Total FY07	Total FY08	Total FY09	Total FY05-09
1.1	Subproject 1.1	1,782,301	25	24	189,962	1,387,884	408,798	242,617	0	2,229,262
1.2	Subproject 1.2	15,455,224	42	38	1,878,446	6,279,783	7,488,061	5,243,034	760,881	21,650,205
1.3	Subproject 1.3	12,060,969	38	29	626,974	4,153,377	6,550,615	4,584,165	554,647	16,469,779
1.4	Subproject 1.4	12,255,743	35	26	493,307	3,273,761	5,284,336	5,407,909	1,857,153	16,316,466
1.5	Subproject 1.5	3,810,441	37	28	576,829	1,787,641	2,200,635	483,834	92,353	5,141,292
1.6	Subproject 1.6	9,528,012	26	32	1,387,220	4,217,436	3,228,831	2,644,198	793,915	12,271,600
1.7	Subproject 1.7	7,473,388	36	32	1,037,385	2,477,510	2,533,646	3,822,933	138,581	10,010,055
1.8	Subproject 1.8	12,049,564	33	53	637,053	2,149,757	2,650,919	4,505,693	7,102,824	17,046,246
1.9	Subproject 1.9	12,180,678	41	29	392,998	2,669,086	3,571,366	5,089,817	4,614,014	16,337,282
1.10	Subproject 1.10	6,866,456	23	61	316,564	977,322	1,886,566	3,805,638	3,297,943	10,284,034
2	Subproject 2.0	25,939,811	39	39	7,463,221	10,006,797	8,501,080	6,542,194	3,545,354	36,058,645
3	Subproject 3.0	5,980,754	21	20	1,885,738	2,807,747	2,519,673	0	0	7,213,157
4	Subproject 4.0	5,254,538	22	23	1,072,863	1,425,459	1,433,768	1,316,329	1,227,544	6,475,962
	BTeV	130,637,879	35	37	17,958,561	43,613,560	48,258,292	43,688,362	23,985,210	177,503,985

Base Cost = $130.6M, Total Cost = $177.5M, Contingency = 36%

Total M&S = $99.4M, Total Labor = $78.1M

Total Cost by FY (FY05 $)



Lab Funding Profile

	FY05	FY06	FY07	FY08	FY09	Total
Then-yr	13.1	41.2	51.2	51.7	44.9	202.1

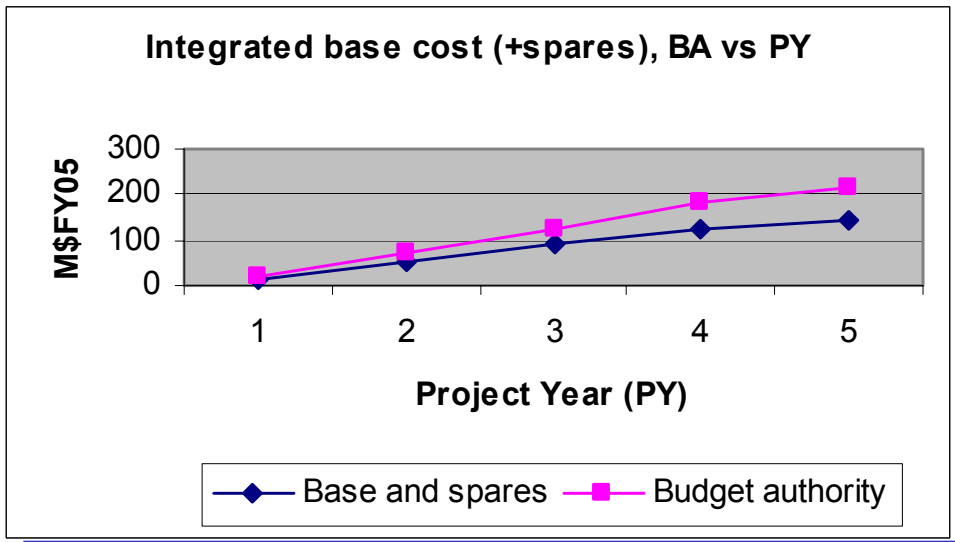
The plan we have put forward is consistent with lab funding profile guidance. The funding profile, which is "back-end" loaded, we have met by

1. **Deferring as many costs as possible, especially components such as computers whose cost fall with time**
2. **By using phased contracts**
3. **By seeking a forward funding arrangement with universities. The one with Syracuse, for $7.5M has made it through their system and is awaiting final approval. Others are being investigated**
4. **We hope eventually to get support from other funding agencies, including INFN and NSF. These are not assured but we are working with them. They have supported the R&D.**

We have an aggressive plan that uses more contingency in later years than in early years

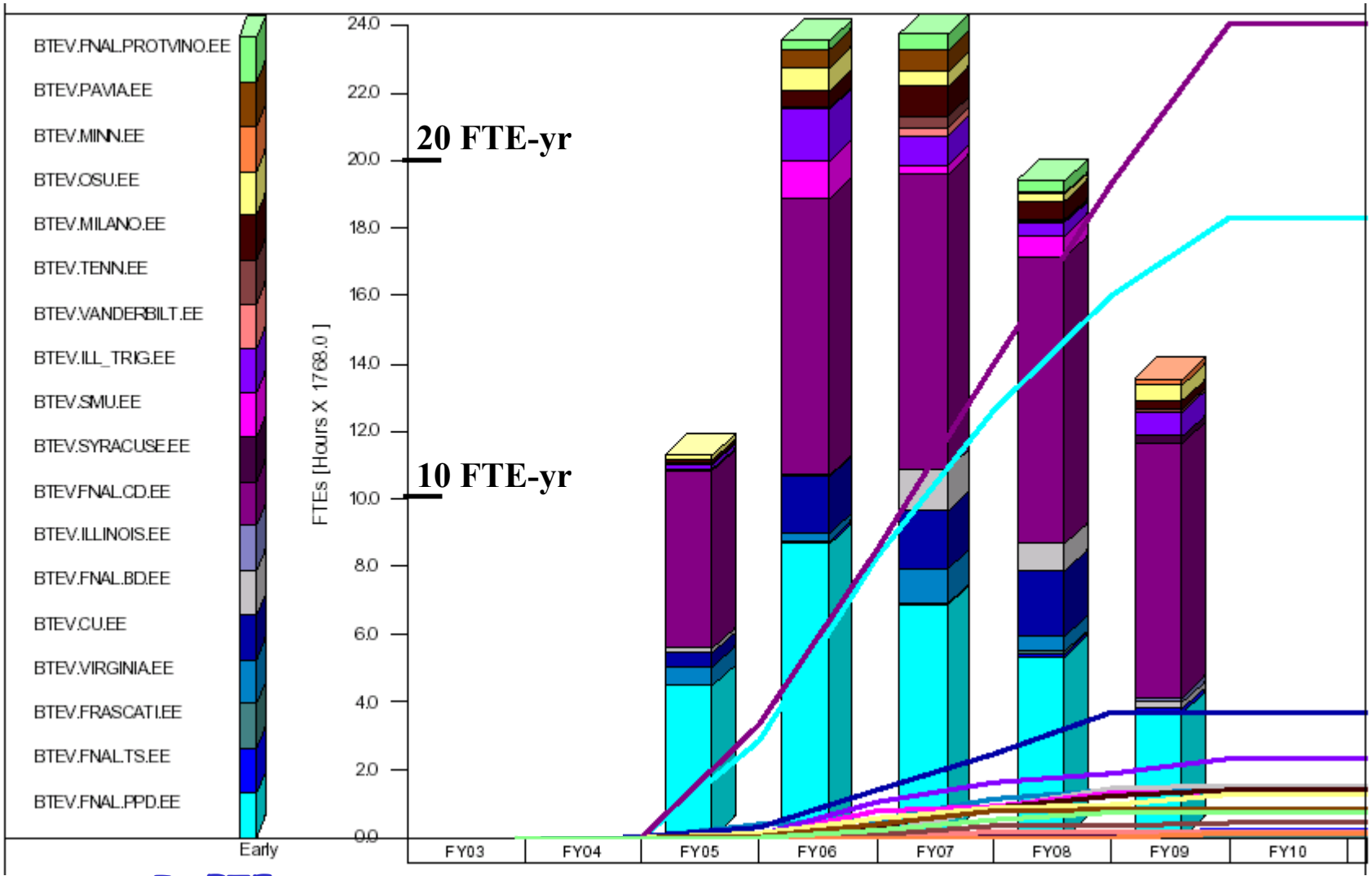
Lab Funding Profile

BTeV Project Estimate						
Cost Profile - M$ AY	FY05	FY06	FY07	FY08	FY09	
Equipment Base Estimate	6.75	31.3	37.7	35	19	129.75
Contingency	2.2	10.5	14	12.8	8	47.5
Total Equipment	8.95	41.8	51.7	47.8	27	177.25
IR Spares	1.5	0	1.6	1.6	1.7	6.4
IR Spares Contingency	0.6	0	0.6	0.7	0.7	2.6
R&D	6.95	2.2	0	0	0	9.15
R&D Contingency	2.1	0.6	0	0	0	2.7
Total BTeV Costs	20.1	44.6	53.9	50.1	29.4	198.10
Availability of Funds - M$ AY						
R&D DOE	4.24	2.2	0	0	0	6.44
OP DOE	2.1	0	2.2	2.3	2.4	9
MIE DOE	6.75	39	49	49.4	42.5	186.65
Total DOE	13.09	41.2	51.2	51.7	44.9	202.09
Univ Forward Funding	7.5	0	0	0	-7.5	0
Total Availability	20.59	41.2	51.2	51.7	37.4	202.09
Integrated total BTeV Base Costs	15.2	48.7	88	124.6	145.3	
Integrated total BTeV BA	20.59	61.79	112.99	164.69	202.09	



Other funds are being sought from the INFN and US NSF. This is still at the proposal stage and is by no means certain. If they were obtained, they would help ensure BTeV could meet its schedule and insulate BTeV against budget shortfalls in DOE. The amount requested in these proposals is about $28M.

Resource Profile (All Electrical Engineers in the BTeV Project)



In FTE-yrs

05 06 07 08 09

An Integrated Schedule

- **Plan: complete the detector in FY 2009 and begin to run. Our competition, LHCb, will begin in 2008 but will probably not accumulate much quality data in 2008. In 2009 they will do better. BTeV is a more efficient experiment due to the pixel detector and trigger and has better calorimetry and will overtake them quickly if it starts in 2009 and comes up very quickly**
- **This schedule is driven/constrained by**
  - **LHCb**
  - **Budget**
  - **Access to Collision Hall: possible only during machine shutdowns for RUN II**
  - **Interference between the various parts of the BTeV Project itself**
  - **Technical considerations (practical rate at which things can be done)**
- **Because of the open architecture of BTeV, our plan is to install the key infrastructure of the experiment - magnets, toroids, and beampipes - by 2007. Then, we can install components of many detectors during short shutdowns and commission them before the long shutdown to finish the installation in 2009**
- **This will help us come on very quickly in 2009.**

Staged Installation/ Rolling Startup

- **Trigger and DAQ will be completed last because it makes sense to wait on items whose price is falling with time**
  - **However, we will have enough capacity in the preprototype system, ~10%, for detector testing in 2007**
  - **We will have 25% of the full trigger and DAQ in 2008**
  - **We will complete the system in 2009**
- **Detector**
  - **We will have a 10% pixel system operational in 2007 and the full detector ready for installation in early calendar 2009**
  - **We will have significant portions of the forward straw detector in 2007 and 2008, some of which could deployed in C0 for testing**
  - **We will have the Muon system fully assembled and the RICH partially assembled in 2008**
  - **We will have 2/3 of the EMCAL in 2008, with completion in 2009**

Critical Decision and Level 1 Milestones

We have the Critical Decisions 0-4 and Level 0 milestones, 8 Level-1 Milestones, 27 Level-2 Milestones and about 100 Level 3 milestones.

No.	WBS	milestone	Internal Date	Formal Date
L1-1	2.0	Purchase Order awarded for superconducting wire	Jul. '05	Sep. '05
L1-2	3.0	Beneficial occupancy of lower level and upper staging area of C0	Feb. '06	Jul. '06
L1-3	1.1	Vertex Magnet installed in C0 and powered	Oct. '06	Aug. '07
L1-4	1.2	PO awarded for production pixel hybridization	Feb. '07	Jun. '07
L1-5	1.4	20% of PWO Crystals accepted	Nov. '07	Mar. '08
L1-6	1.2	Pixel System assembled and tested at SiDet, ready to ship to C0	Mar. '09	Aug '09
L1-7	2.0	IR Components complete, installed and under power	Oct. '09	Feb. '10
L1-8	1.0,1.10	Detector complete and ready for commissioning with beam	Oct. '09	Feb. '10

Project Flow

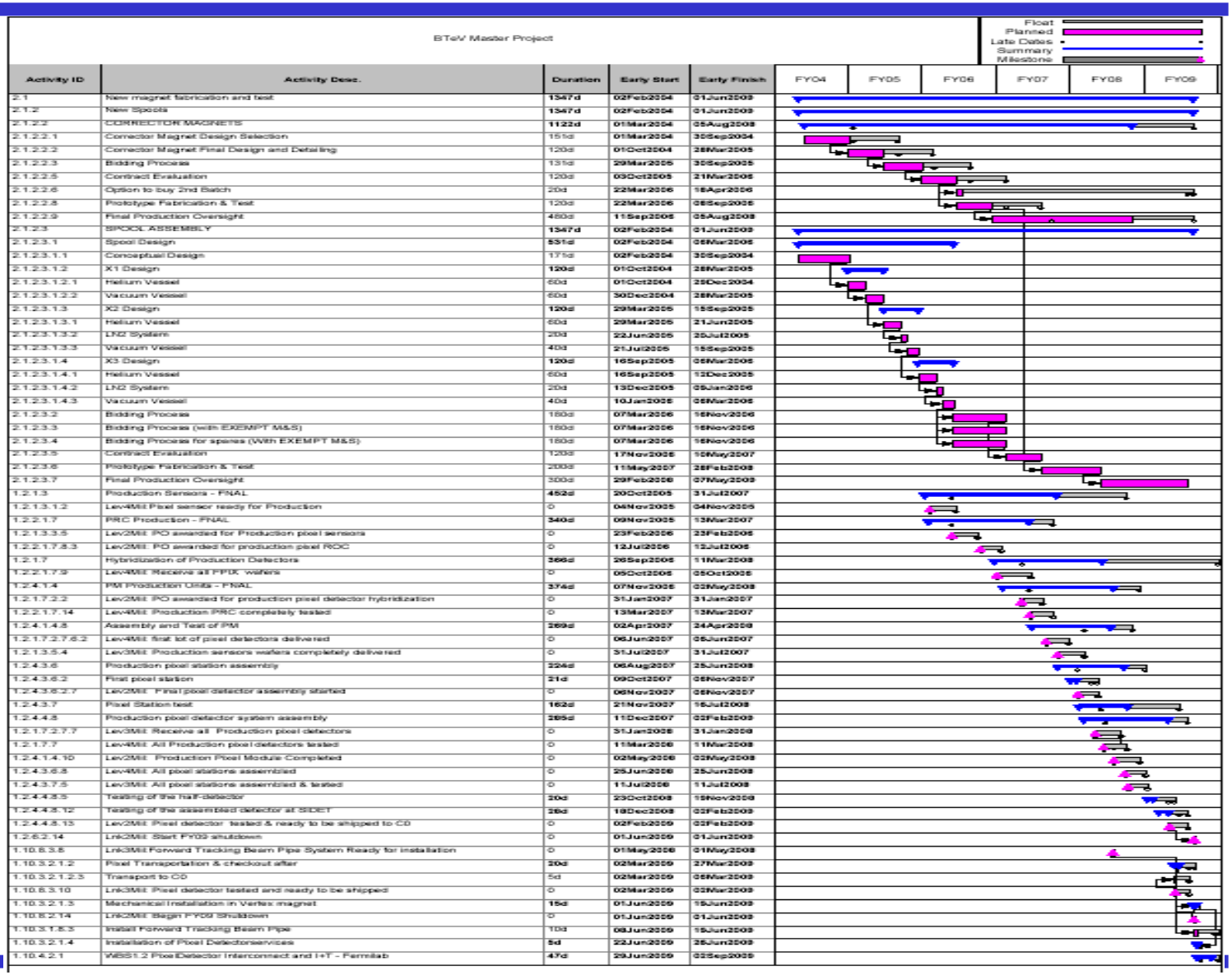
- This project must respect the constraints of
  - **The budget profile**
  - **The schedule of downtimes in Tevatron operations**
- We have a good understanding of how the three major Level 1 projects interact with each other and the Shutdown Schedule (talk by Joe Howell, BTeV Document 2605, on the review home page)
- The critical path items for running in 2009 and for the project as a whole are
  - **The IR**
  - **The Pixel detector**
- We want to begin operations in 2009 and we can do it with a partially complete detector that will still be capable of doing physics.

Selected Critical Tasks

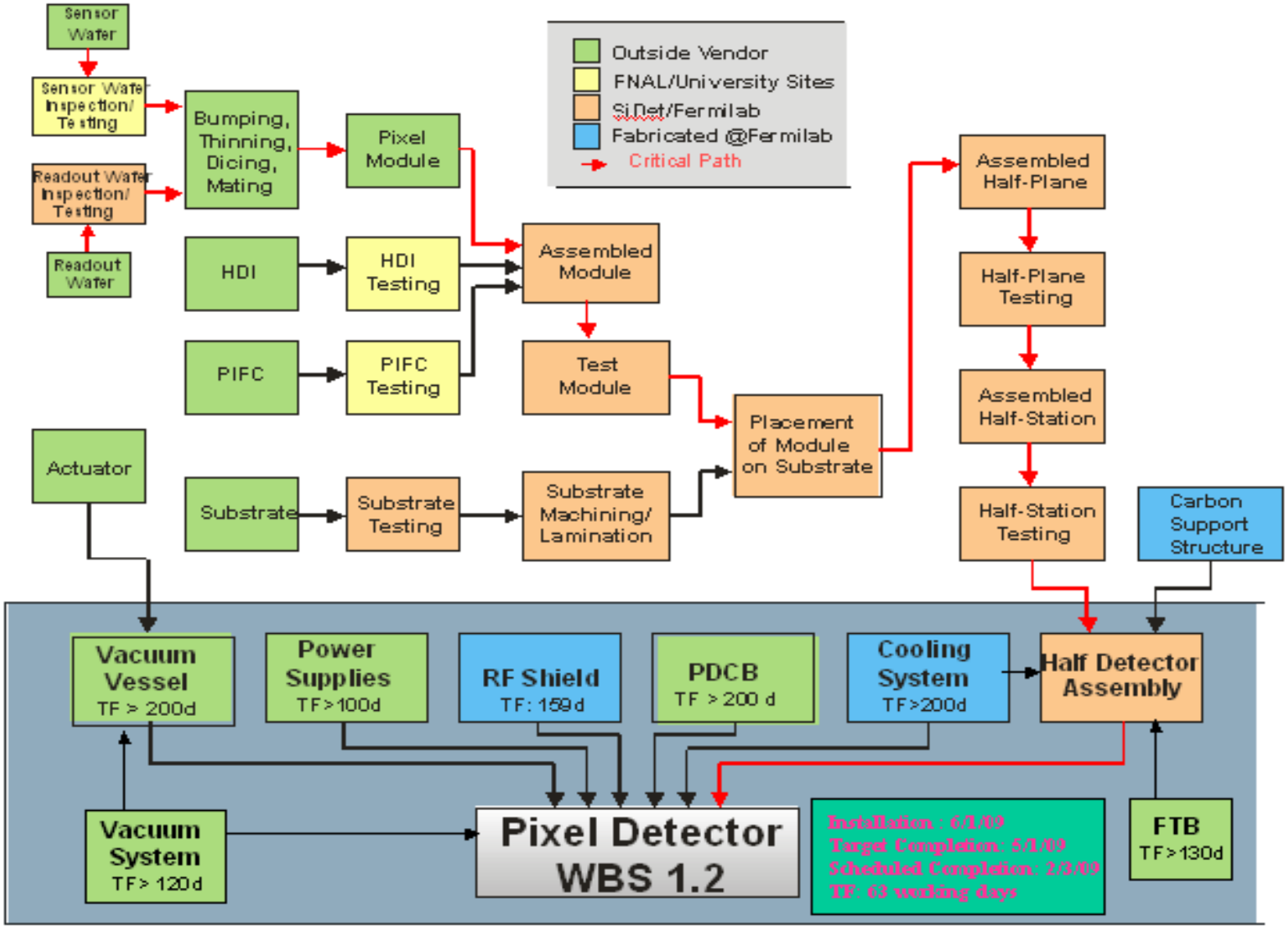
IR

Pixels

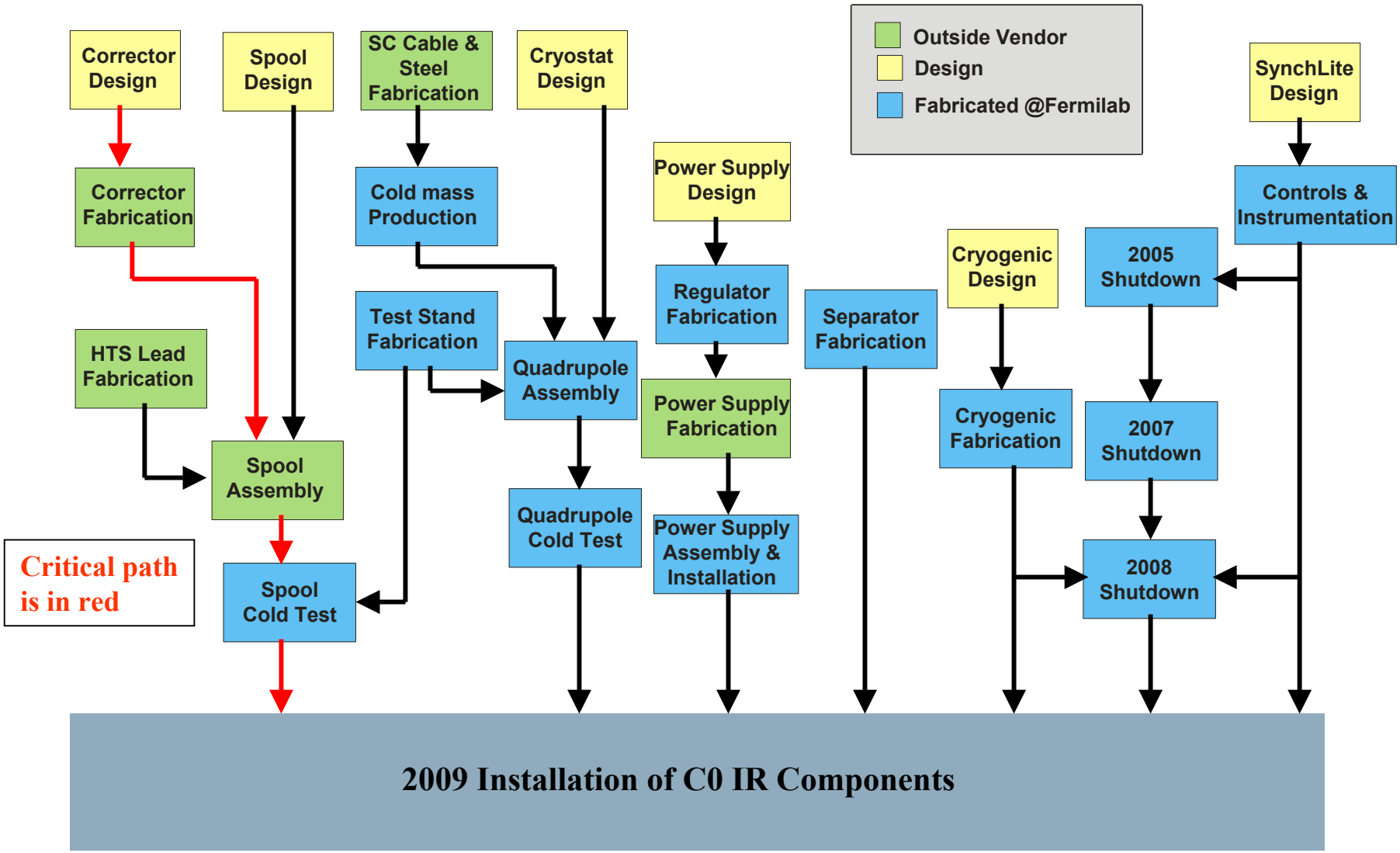
I & T



Description of Project Flow WBS 1.2



Project Flow



Risk Analysis (examples)

Risk	Mitigation
1. We cannot achieve the vacuum required due to gas load much bigger than expected or there is not enough room to put in big pumps or panels (1.2.3.8.2), see BTeV Doc #1145	**1. In order to make room for pump-out ports or reduce outgassing, we may have to reduce the length of the detector. In the worst case scenario, we may be forced to run the detector not in vacuum**
2. Superconducting Cable and other procurements, doc #2629	**2. Make procurement as early as possible**
3. Shutdown schedule changes	**3. Make alternate plans for recovery and to take advantage of short shutdowns**
4. Funding Profile	**4. Continue to try to get additional funding; develop staging and descoping scenarios**

Every subproject has a Risk Analysis document that is in their management documents and notebooks. We are beginning to undertake a project-wide risk assessment based on them and other concerns

General Documentation

- CDR for full project
- Draft TDR for Detector
- Advanced CDRs
  - **IR**
  - **C0 Outfitting**
- **Results of several recent reviews**

Draft Management Documents:
CD-0 Document
Preliminary Project Management Plan
Preliminary Project Execution Plan
Preliminary Acquisition Strategy Plan
Hazard Assessment Plan

Subproject Documentation

Each SUBPROJECT has:

- **Project Workbook with**
  - WBS dictionary and BoE
  - Requirements
  - Participants, Group Organization
  - Personnel Expertise
  - Production, Test, QA plan
  - Installation, Test Plan
  - Risk Analysis
  - Contingency Analysis
  - Management Plan
  - Cost to WBS Level 4(OB)
  - Total Construction Cost
  - Total Construction Cost by FY
  - Labor FTE by inst/class by FY
  - M&S Cost by FY
  - Large Procurements
  - TDR (Detector)
  - Breakout talks
- **Cost Books**

There is a complete reference set of these all the subproject Workbooks and Cost books for reference in 1 West. They will move to 1N on Weds. Each breakout room will have a few copies of the appropriate books

There is a also a companion CD with The TDR, CDR, Advanced CDRs, many PDFs of subproject information from OpenPlan. Obrowser (OB) is a tool that lets you Navigate information extracted from OpenPlan without needing a license

Key Points for the review

- **We have a technically sound, well-defined project scope that will accomplish our physics goals**
- **The technical design has been stable for two years and has only a few options, which are about equal in cost. The design meets our stated requirements.**
- **Our R&D program has gone a long way to reducing risks**
- **An experienced team is in place to do the project**
- **The experiment has less "coupling" than hermetic central collider detectors, resulting in lower costs, fewer uncertainties, ease of assembly and integration. We understand the major linkages**
- **Our cost estimate is quite complete**
- **We are trying to take project risks into account from the start**
- **We using formal project management techniques**
- **We have begun to form integrated schedule for the whole BTeV Project to do early commissioning using end-of-store collisions or wire targets in '07/'08 and to begin the experiment in calendar 2009**